

NTIS \$3.00

E7.2-10350

CR-129663

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

Report Summary

Evaluation of ERTS-1 Image Sensor Spatial Resolution in
Photographic Form

Category 9a - Sensor Technology

This report describes progress on NASA/ERTS contract # NAS5-21849 during the period 11/1/72 - 1/1/73. A discussion of progress in obtaining ERTS and simultaneous underflight (U2) imagery is given. In addition, several microdensitometer scans of psuedo-edges in frame #1104-17393 are presented and discussed in reference to our project objectives. The effects of ERTS scan lines on image studies is described qualitatively.

(E72-10350) EVALUATION OF ERTS-1 IMAGE
SENSOR SPATIAL RESOLUTION IN PHOTOGRAPHIC
FORM Progress Report, 1 Nov. 1972 - 1
Jan. P.N. Slater, et al (Arizona Univ.,
Tucson.) Jan. 1973 10 p CSCL 14E

N73-14338

Unclas

G3/13 00350

Evaluation of ERTS-1 Image Sensor
Spatial Resolution in Photographic Form

R. A. Schowengerdt

P. N. Slater

Type I

Progress Report 2

Prepared for

NASA/ERTS Contract Number NAS5-21849

Proposal Number 618

Principal Investigator

P. N. Slater (UN237)

January 1973

Introduction

This report describes progress on this contract during the period 11/1/72 - 1/1/73. We received the first ERTS images (of Arizona) on 11/22/72. These were part of our Standing Order request. Progress made in obtaining simultaneous underflight and ERTS images is described below. Some preliminary qualitative analysis on the ERTS images already received is also presented.

Discussion

A U-2 flight from Ames Research Center was made over the San Francisco area on 11/29/72 at our request. The flight time corresponded with the ERTS pass over the area, thus satisfying our simultaneous imagery requirement. Vinten camera photos and images made from the 4-channel scanner on board the U-2 should be received by us very shortly. A data search is in progress at GSFC to determine the ID number of the ERTS image from that date.

Inquiries about ERTS supporting aircraft flights over Arizona have not uncovered any simultaneous coverage with the ERTS. However we have requested, from Ames, imagery taken over Phoenix during a flight on 8/22/72. This was 24 hours before the ERTS pass over that area on 8/23/72. Only Vinten imagery was obtained on 8/22/72. The Vintens simulate the ERTS RBV's and hence the spectral bands will not correspond to those in the ERTS MSS. We are currently in the process of determining the exact spectral response curves for the Vintens and it may then be possible to make an approximate correspondence with one or more of the MSS bands, allowing comparison of the imagery.

Since none of the above data has been received yet it is not possible to determine its usefulness in satisfying our project goals. In the interim we have been doing some preliminary scanning of the ERTS images received.

A description of qualitative results obtained so far and how they relate specifically to our project is given below.

Preliminary Scans

The frame selected for scanning is depicted in Fig. 1. It is frame #1104-17393 taken on 11/4/72 over the northern end of the Gulf of California. A visual inspection of band 7 through a microscope yielded 3 or 4 coastline regions which may represent suitable edges for scanning. Two of the regions are indicated in Fig. 1 and microdensitometer scans of these areas are shown in Fig. 2. Experimental parameters for the scans are given below:

instrument: Joyce-Loebl Mk III CS microdensitometer

optics: influx (condenser) 5X, 0.1 NA

efflux (objective) 5X, 0.1 NA

aperture: 0.010 X 0.400 mm at the sample

Note that "edge 1" was scanned perpendicular to the ERTS scan direction and "edge 2" was scanned approximately 17° from the perpendicular to the ERTS scan direction.

Comparison of the curves in Fig. 2 indicates the following points:

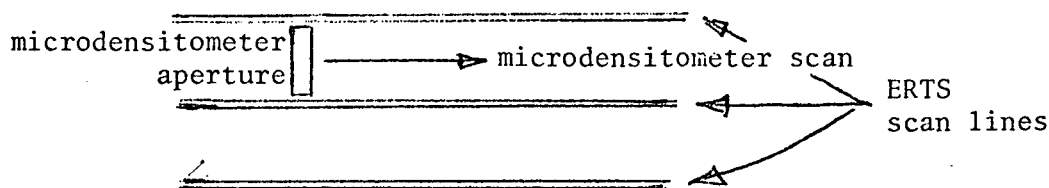
- 1) The presence of the ERTS scan lines is evident in "edge 1", bands 6 and 7. The amplitude of the periodic structure in these scan lines appears to depend on the mean density level, thus resulting in a signal-dependent "noise" in the imagery. These lines will be discussed in more detail later. Note that the combination of aperture size and microdensitometer scan angle effectively eliminates these lines in "edge 2."

- 2) The usefulness of the two coastal regions as edges varies from band to band, a point which we've made before.¹ "Edge 1" appears to be reasonably good for evaluating bands 5, 6, and 7 but "edge 2" is only satisfactory for band 7. However, the point is that the quality of the "edges" as true edges is not known and must be assumed. This is one reason for our use of simultaneous underflight imagery from which we can measure the object scene exactly, thus providing good calibration of the sensor input.
- 3) The choice of aperture size for these scans reduces the grain noise of the film to a sufficiently small value. The granularity will be more important in analysis of bands 4 and 5 because of the lower scene contrast. Furthermore, when scanning is done of both the underflight and ERTS imagery, the necessary scaling of aperture size between the two will require smaller apertures for the ERTS images than used here, thus increasing the noise/signal ratio.

Fig. 3 shows scans of the water area of the same frame. The ERTS scan lines are evident in curves (a) and (b). The mean period of these lines is about 0.140-0.150 mm which is the spatial interval between scans of the 6-detector (in each band) array in the MSS. Whether these lines represent image information lost in the scanning process of the MSS or are an artifact of the EBR reconstruction has not been determined. The amplitude and period of the lines vary and are therefore random variables in the overall imaging process. Curve (c) is a scan parallel to the lines and appears to show no effects from them. However since the amplitude of the lines varies there will also be an unknown effect on scans parallel to the lines, unless many lines are averaged in a scan. Scans could be done in the direction parallel to the lines with a slit whose length is equal to the image width between

¹ R.A. Schowengerdt and P.N. Slater, "Determination of the Inflight OTF of Orbital Earth Resources Sensors," presented at ICO-IX Congress, Santa Monica, Calif. October, 1972.

lines, i.e.:



The effects of the scan lines could thus be eliminated for image analysis purposes.

Future Plans

During the next two month period, we will receive all the imagery mentioned earlier. Flight path and timing details will then be determined and frames satisfactory for the first detailed analysis will be selected. A more detailed analysis of the curves in Fig. 2 will be pursued, including manual digitizing and MTF calculations. Because of the uncertainties associated with the "edges" as mentioned above, any quantitative results may not be accurate.

In addition a Data Analysis Plan will be prepared for submission by 3/1/72 (3 months after receipt of our first ERTS data).

Comments on Imagery

We have received 18 ERTS frames covering Arizona during the period 11/1/72-11/5/72. A distinct difference was noted among the imagery. The frames from 11/1/72 and 11/2/72 were visually sharp, including the data annotation. They also appeared in the proper orientation when viewed emulsion side up. The remaining frames from 11/3/72-11/5/72 were visually less sharp, including the data annotation. They appeared in the proper orientation when viewed emulsion side down. Thus it appears that either the original archival film or succeeding duplicating films were exposed through the base side of the emulsion. This error should be corrected.

and every effort made to see it does not reoccur.

Frames Studied

#1104-17393

Data Requests Submitted

dated 11/29/72

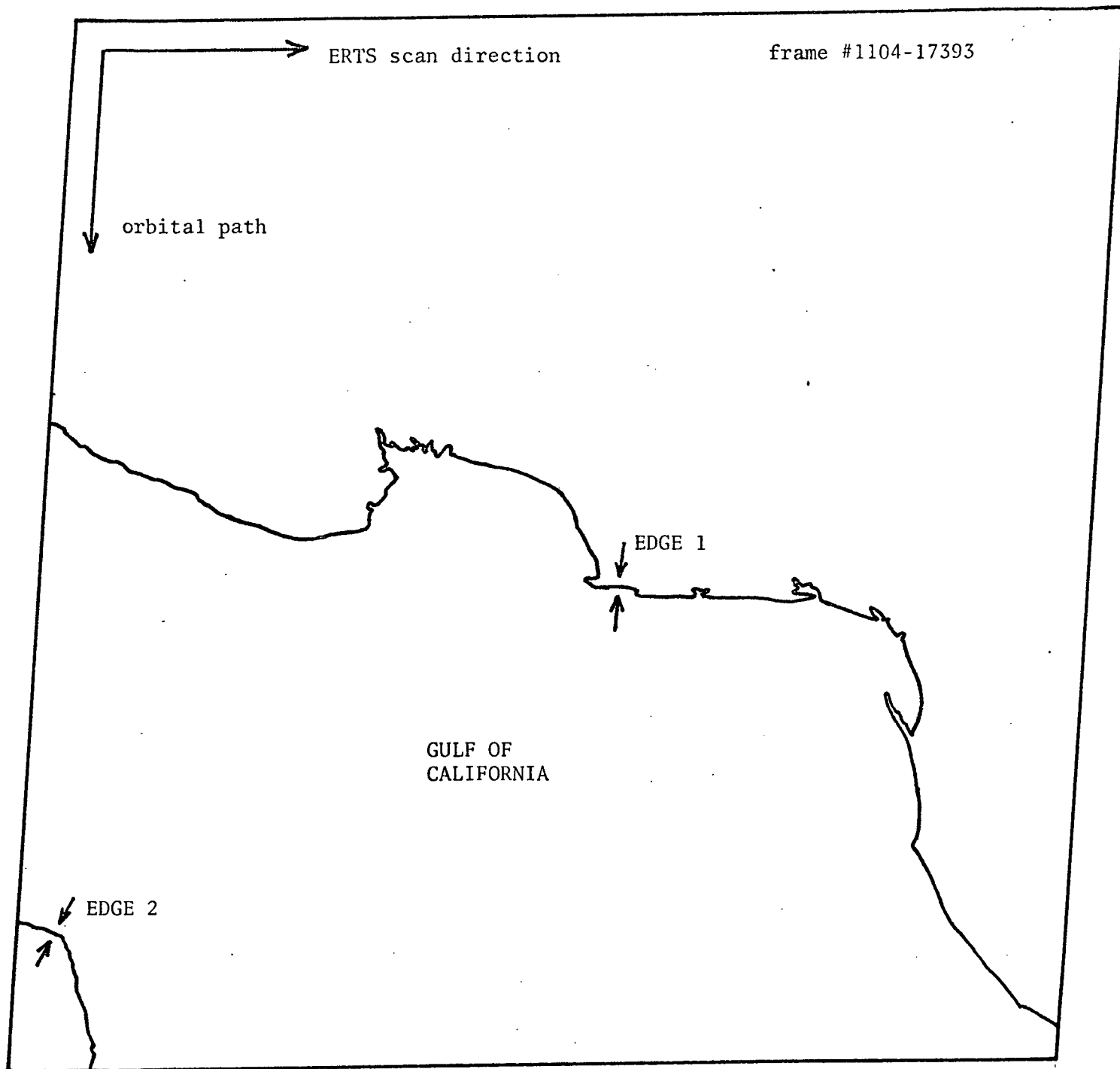
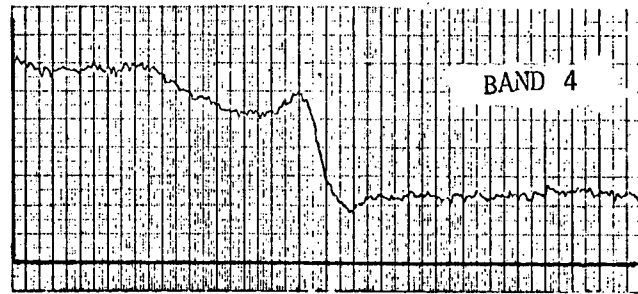
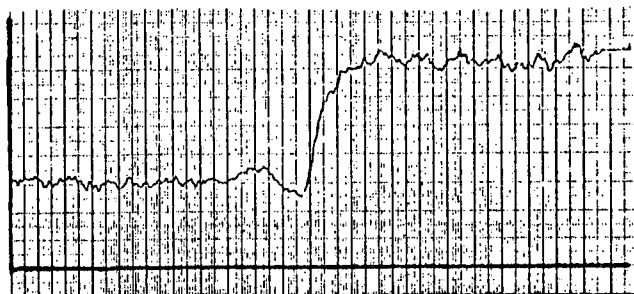
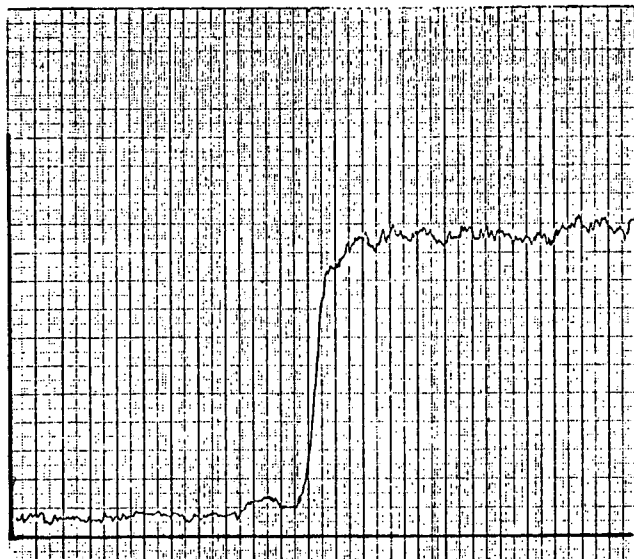
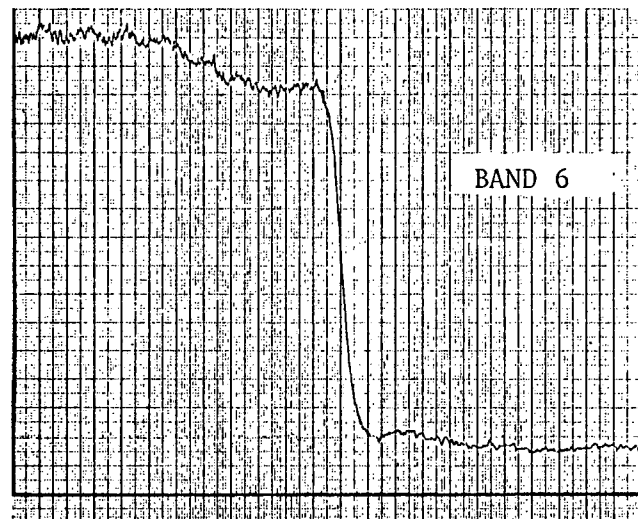
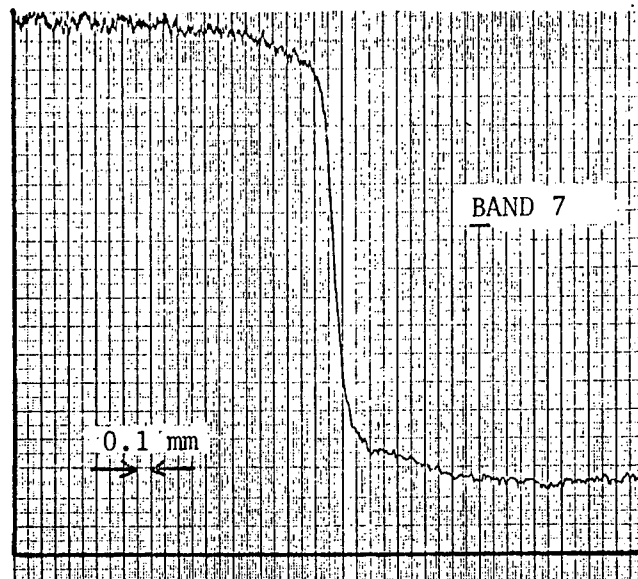
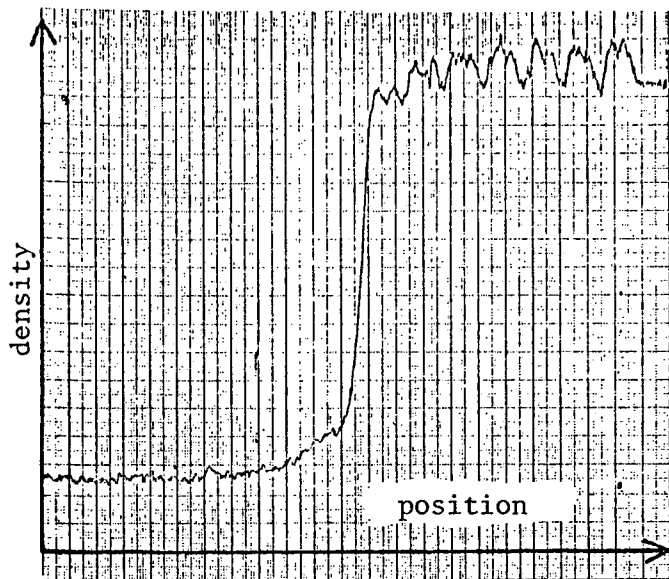


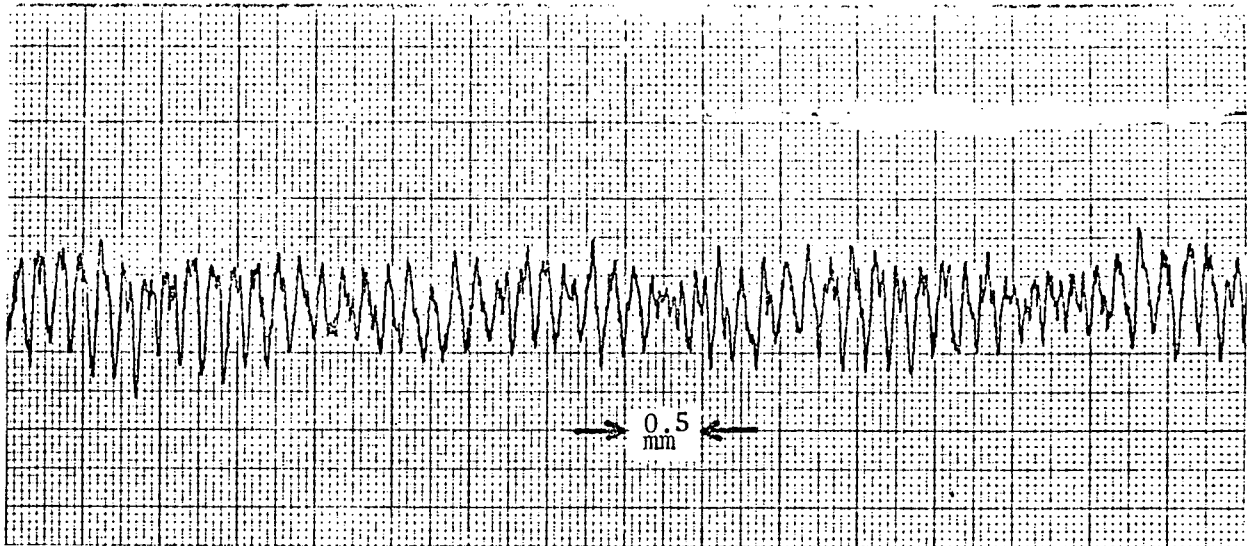
Figure 1



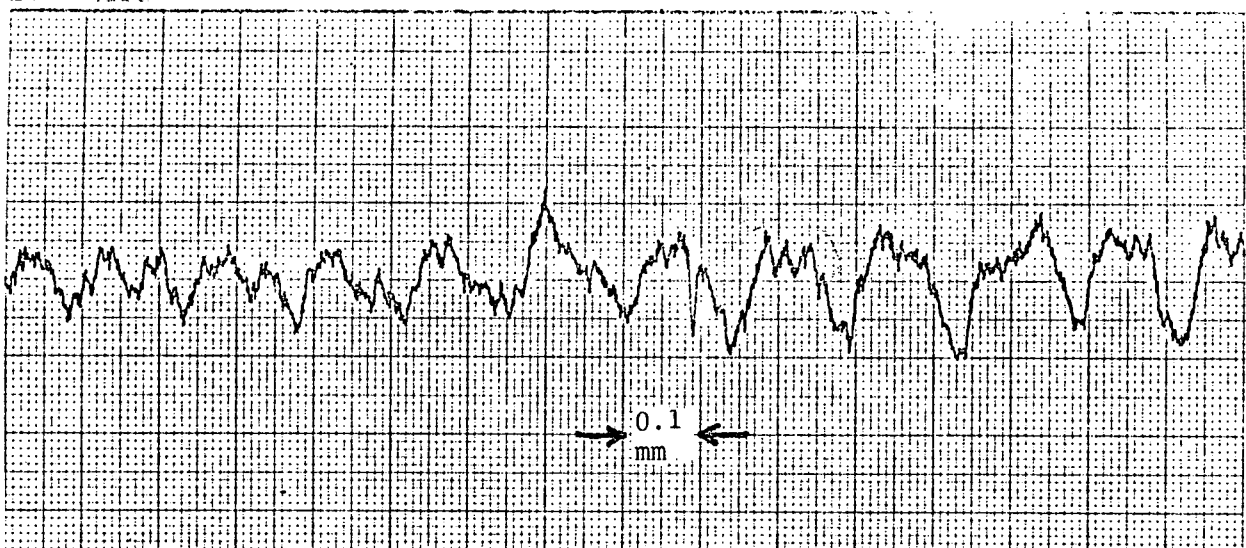
EDGE 1

Figure 2

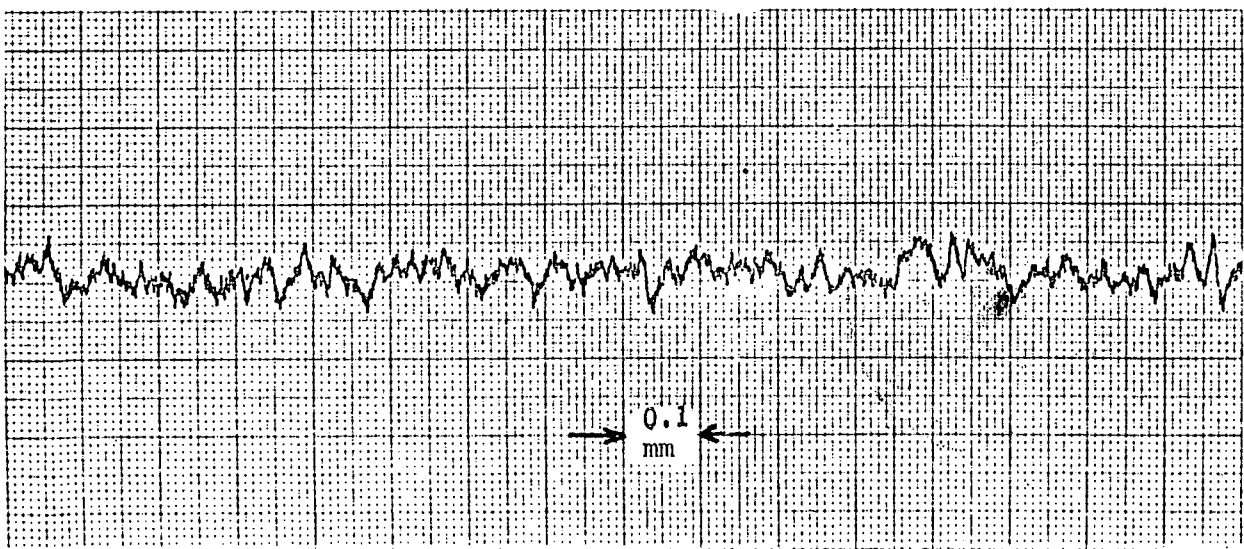
EDGE 2



(a) Microdensitometer scan perpendicular to ERTS scan direction



(b) Same as (a) with expanded horizontal (position) scale



(c) Microdensitometer scan parallel to ERTS scan direction